Development of the Data Pipeline for a Connected Vehicle Corridor

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Motivation

- This connected corridor project is a preliminary attempt and a practical implementation of the CV technology.
- The edge architecture improves the system's resilience and increases the system's redundancy.
- The distributed processing and edge computing facilitate the operation of the overall system with increasing scale.
- The system demonstrates the potential of information transfer between the road infrastructure and remote servers, and the communication between vehicles and road infrastructure.

Connected Corridor

The Connected Corridor is designed and deployed on the existing arterial and freeway in Madison. 15 RSUs are installed along the Park Street and 6 RSUs are installed along the Beltline Highway.

- A set of RSU is installed on the traffic signal pole at each intersection to collect and integrate the data from the traffic signal controller and the data transmitted from the OBU installed on the CAVs.
- Virtual edge computers are set up in the data center in order to acquire remote access to the RSU.
- Dedicated Short Range Communications (DSRC) enables the communication between OBU on the vehicles and RSU.

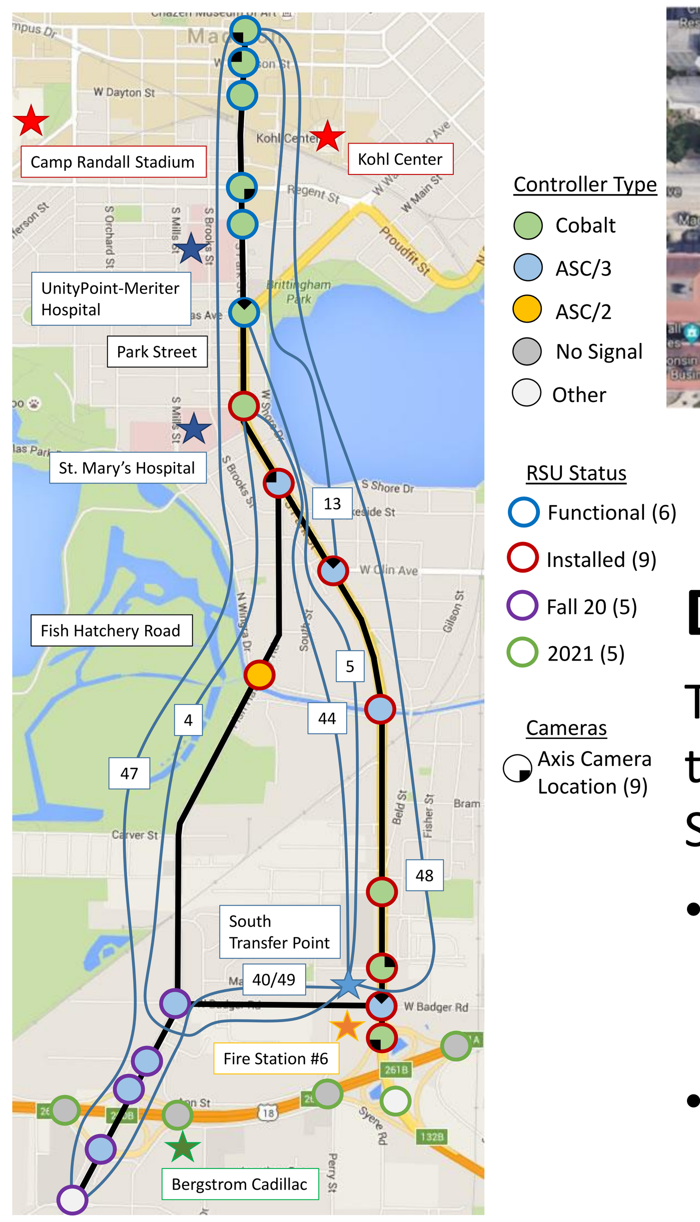

Figure 1. RSU Layout of the City of Madison Arterial

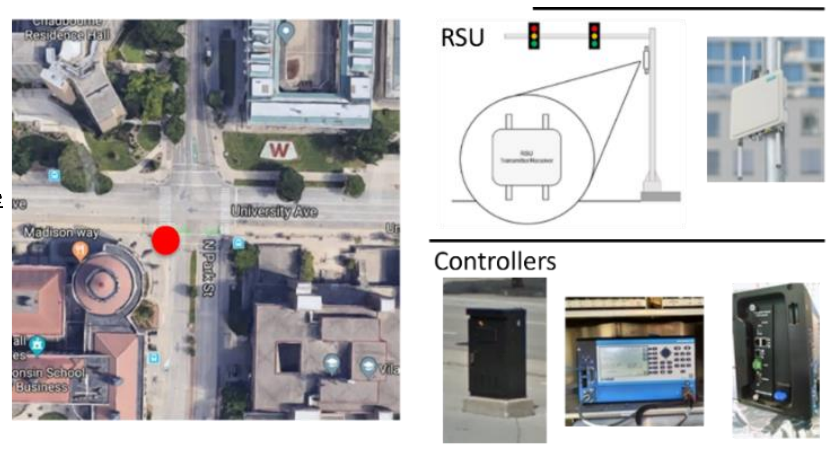

Figure 2. Park Street Connected Corridor Intersection Configuration

DSRC Message Type

This project investigated 3 major types of messages defined by the SAE standard J2735-2016 :

- Signal Phase and Timing (**SPaT**): indicates the current status of one or more signalized intersections.
- Intersection Mapping (**MAP**): describes a full geometric layout of an intersection.
- Basic Safety Message (**BSM**): provides the dynamic and static status of vehicles.

Data Pipeline Architecture

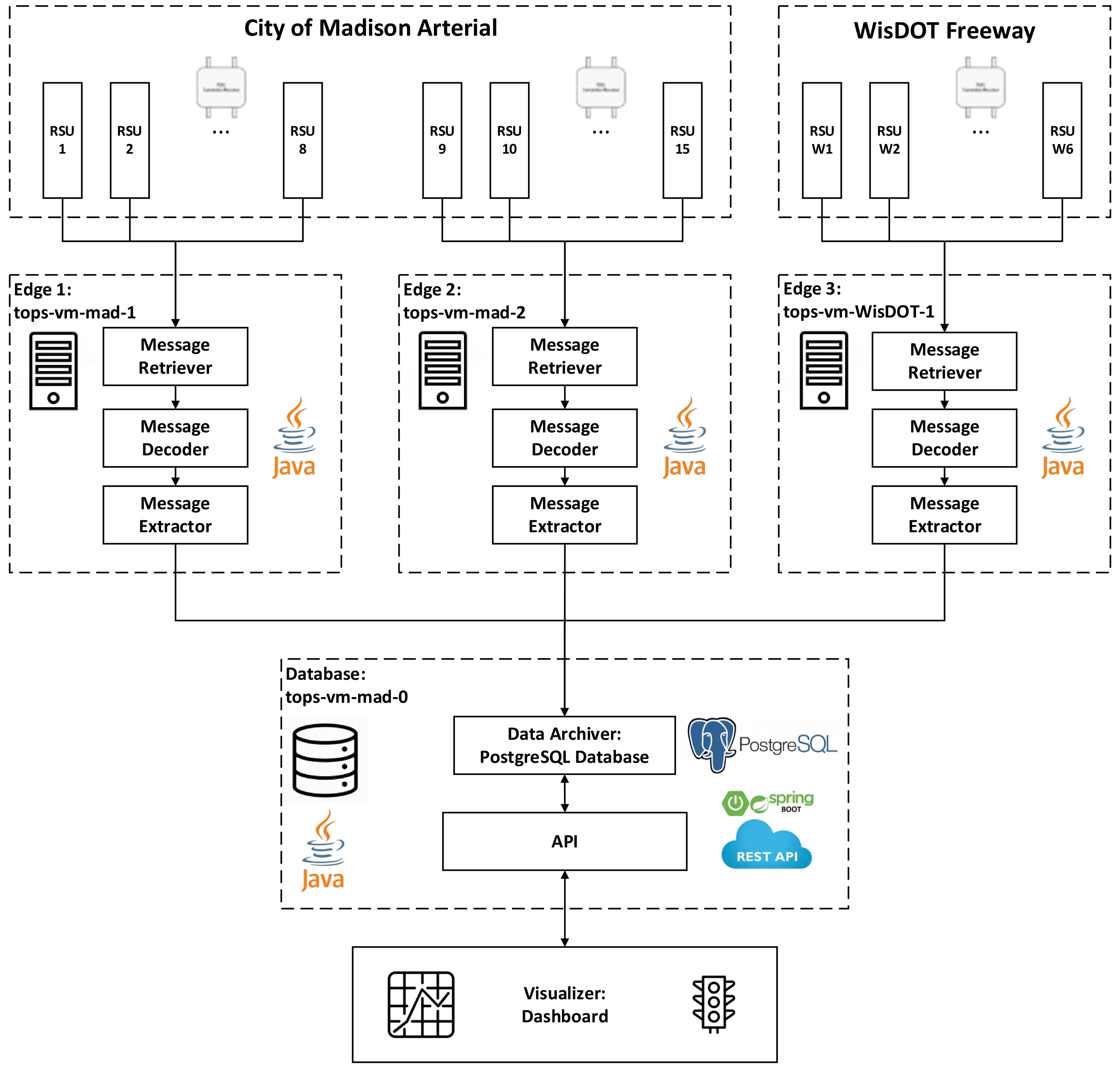

Figure 3. Data Pipeline Architecture

An edge architecture is adopted for RSUs installed on City of Madison arterial and WisDOT Freeway, which improves the system's resilience as the distributed processing of the RSU at the system's edge reduces the probability of single points of failure. This system contains the following five modules:

- **Message Retriever** module: subscribes to an RSU and receives the messages sent from the RSU.
- **Message Decoder** module: decodes the received messages.
- **Message Extractor** module: extracts the essential information and organizes the data in structured format data.
- **Data Archiver** module: instantaneous and historical data storage.
- **Visualizer** module: real-time and historical data visualization.

Data Pipeline Workflow

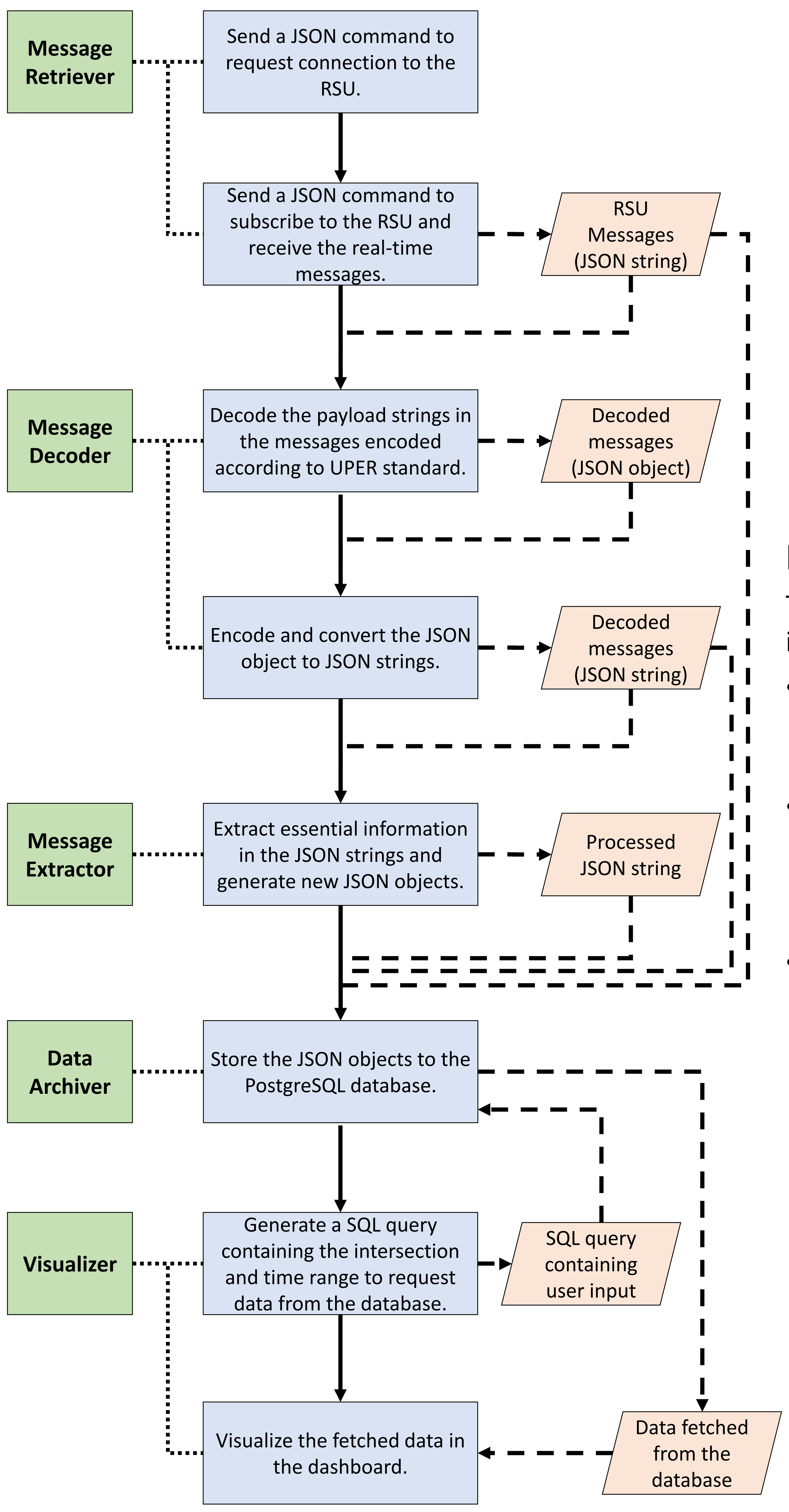

Figure 4. Workflow and data flow of the modules

Dashboard Interface

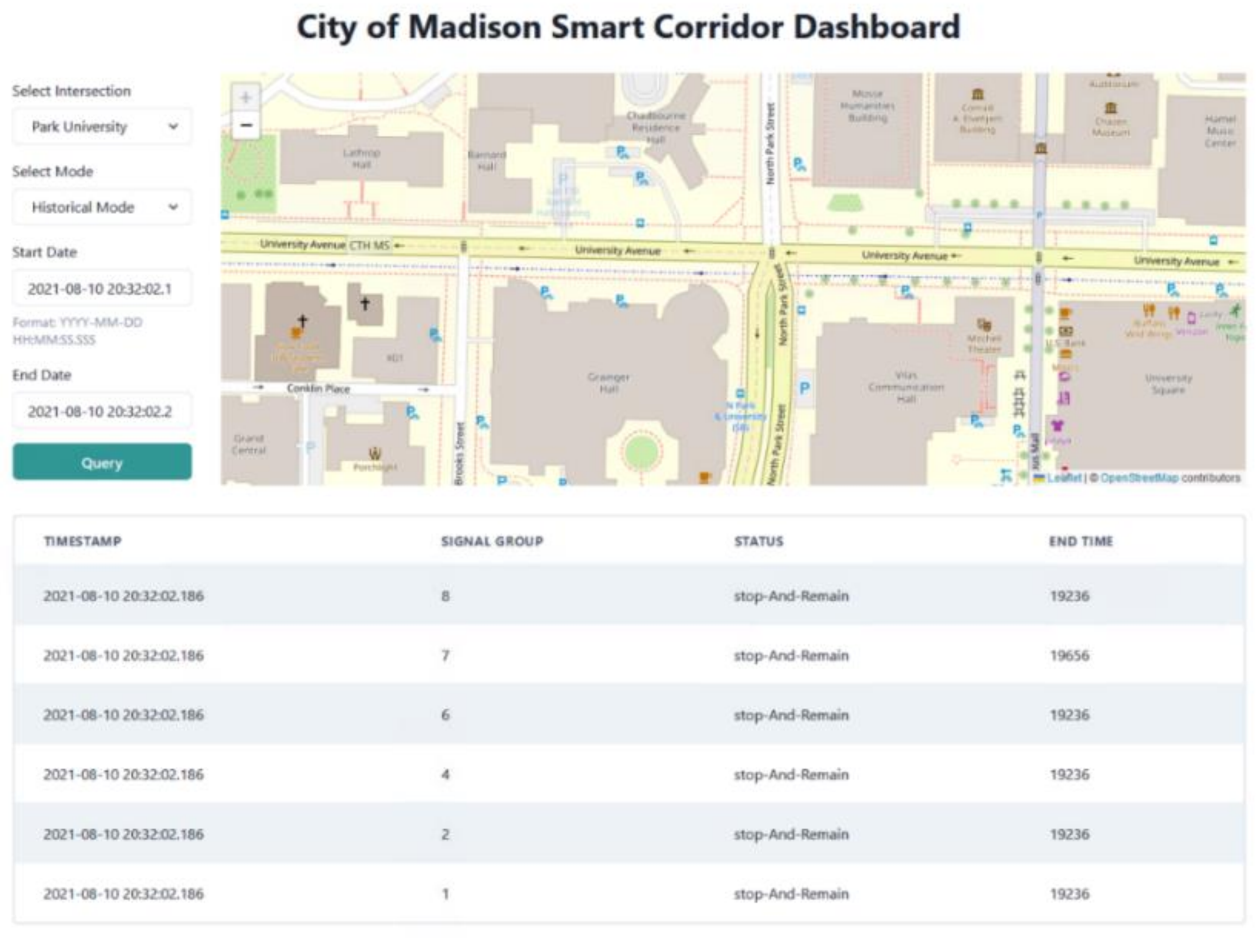

Figure 5. The User Interface of the Dashboard

Discussion and Conclusions

To further develop and improve the data pipeline system, several issues should be considered:

- **The C-V2X Update.** The current Message Retriever should be upgraded to adapt to fully take advantage of the new C-V2X communication function.
- **Performance Measurement.** The latency of the data pipeline program is critical to the performance of the system. The efficiency of the overall program should be considered, and enhancement is required.
- **System Scalability.** The current adoption of edge computing should be inherited for future expansion of the Connected Corridor project. Edge computing facilitates the operation of the overall system with increasing scale, and reduces the probability of single points of failure, which improves the system's resilience.

Acknowledgement

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